Interactive Earth Science Data Visualization Gallery (vizGal)

Roland Schweitzer[1], Steve Hankin[1], Velimir Mlaker[2], Bob Drach[2] and Dean N. Williams[2]
[1]Pacific Marine Environmental Laboratory (PMEL) and [2]Lawrence Livermore National Laboratory (LLNL)

Summary

Many scientific institutions are running sophisticated Earth system models as part of the global effort to understand and predict the state of the Earth's climate. These institutions have invested heavily in the development of their model codes and the computing infrastructure necessary to run the complex coupled climate studies. Increasingly, the climate modeling community understands that the behavior of a particular model is best understood when it is possible to compare it to the behavior of other related models. A quick scan of the scientific literature shows the importance of past and present formal model inter-comparison projects. The Earth System Grid (ESG) played a critical role in the success of the Nobel Peace Prize winning CMIP3/AR4 climate model intercomparison and analysis in 2006-07. The ESG will play a similar role in the forthcoming CMIP5/AR5 intercomparison and analysis.

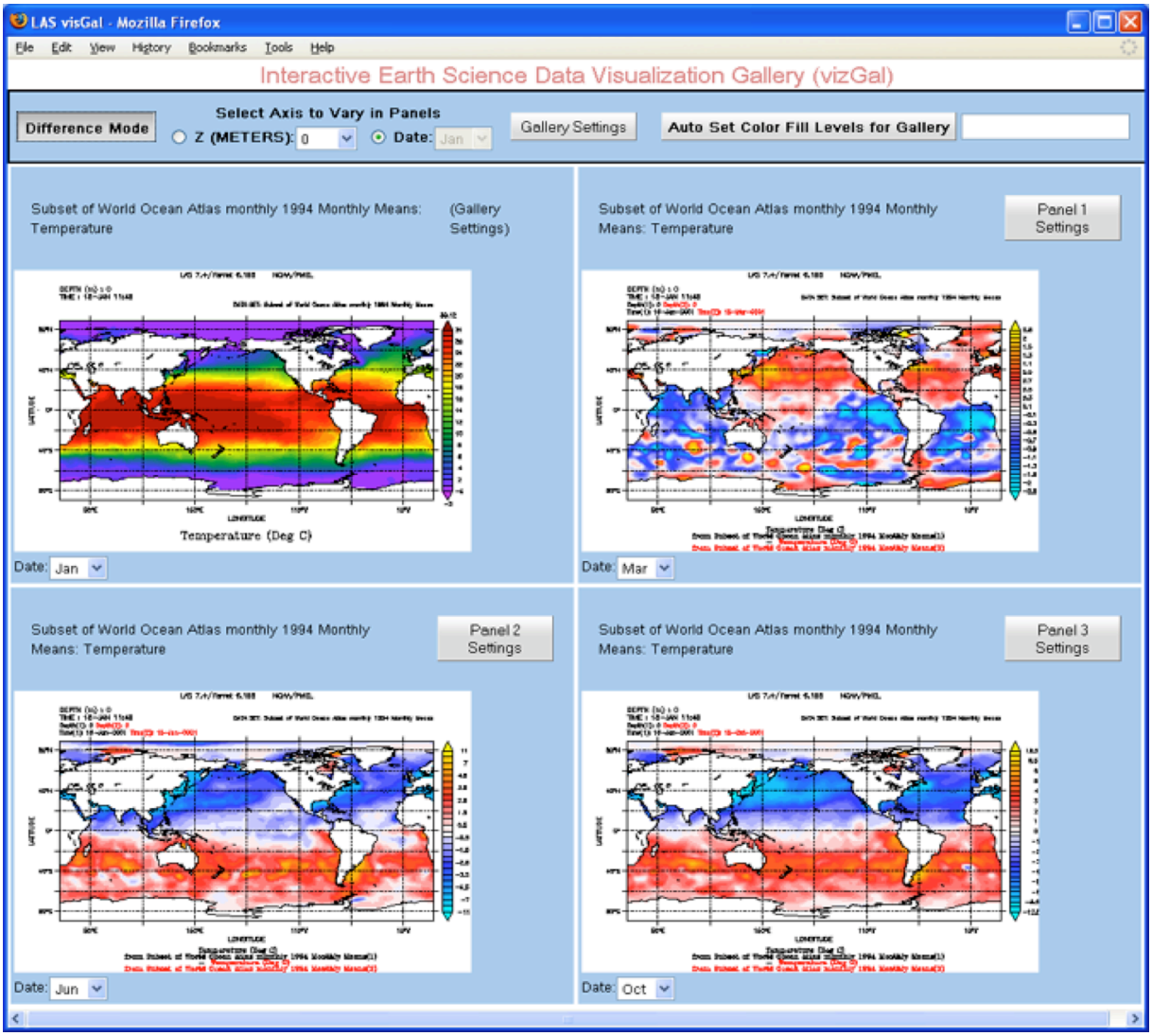

Figure 1. Monthly mean displays, showing the January difference of sea surface temperature.

The Earth System Grid Center for Enabling Technologies (ESG-CET) has developed a suite of flexible web-based data access and scientific visualization tools that facilitate direct model-to-model comparisons and visualizations. These new tools break down many of the traditional barriers that have inhibited model inter-comparisons such as the vast size of the datasets; physically distributed files; differing and sometimes challenging coordinate systems; and the subtle metadata that explains the differences between model configurations.

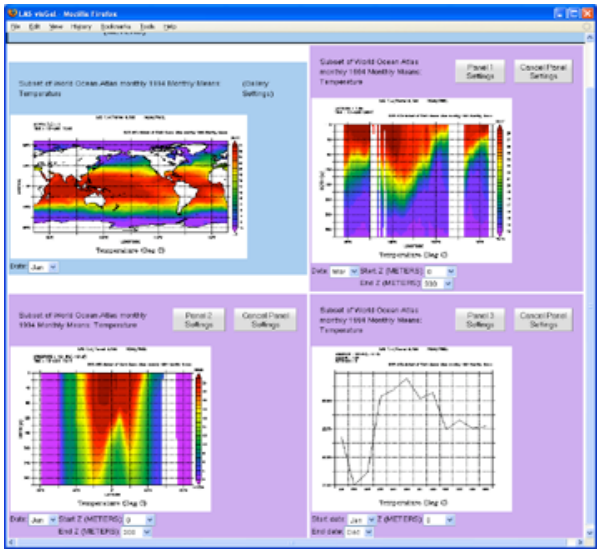

Figure 2. The display shows four different cutting planes for the same data (latitude/longitude, longitude/depth, latitude/depth and time).

At the heart of the ESG enterprise system is a federated data management infrastructure that allows model outputs to be published and shared. Once data have been published into the ESG system, a registered user with the necessary permissions to view model outputs can call up the Interactive Earth Science Data Visualization Gallery (vizGal) user interface in his web browser (see **Figure 1**). From this interface, the user can easily create an interactive gallery of related visualizations – created on-the fly to the user's precise specifications. The gallery can contain images from the same model or from different models. The user can ask vizGal to compute and display the differences between model fields (see **Figure 1**). The user can also compare the fields along various cut planes and axes (see **Figure 2**).

The ESG-CET team leveraged several ESG components and developed innovative new user interface elements to build the vizGal system. The workflow engine behind vizGal is the Live Access Server (LAS), a flexible web server for analysis and display of Earth science data. LAS in turn leverages desktop tools such as Ferret and the Climate Data Analysis Tools (CDAT) to render plots described as XML workflows as actual images.

VizGal takes advantage of the remote data subsetting capabilities of ESG-CET OPeNDAP servers to move only the minimum data necessary to create the product across the Internet. Calculations such as averages over ranges of time or depth (not shown) are also performed on the server to minimize data transfers. Additionally, the LAS system uses a sophisticated cache system to reuse plots and computations whenever possible. VizGal leverages the capabilities of the F-TDS server (an enhanced version of the THREDDS Data Server from Unidata) to re-grid data fields as needed to compute differences.

The vizGal user interface, which offers a level of interactivity that rivals desktop applications, builds upon the Google Web Toolkit (GWT). GWT abstracts and hides browser incompatibilities from the developer. It leverages the same high-productivity development tools used for Java development in other areas. Unlike most browser user interface development environments, in which the programmer writes code in a scripting language called JavaScript, GWT code is developed and debugged entirely in Java using a standard Integrated Development Environment (IDE) tool in which the programmer can set break points, examine variables and step through code without leaving the IDE. This approach seamlessly integrates the development of code for the client and server -- decreasing complexity and increasing productivity for the software developer.

VizGal as a component of the ESG-CET will enable climate model inter-comparison to progress with unprecedented ease and speed helping in the advancement of climate science.

For further information on this subject contact:
Name: Roland Schweitzer
Organization: PMEL, NOAA
Email: Roland.Schweitzer@noaa.gov